CA2ALEN3
A56
1968-69.

ALBERTA LEGISLATURE LIBRARY
3 3398 00459 9667

LIBRARY
VAULT 19

LEGISLATURE LIBRARY
OCT 14 1982
EDMONTON

WATER RESOURCES DIVISION
SOILS, GEOLOGY AND GROUNDWATER BRANCH
ALBERTA DEPARTMENT OF AGRICULTURE

IRRIGATION STUDY BASIN

Annual Report No. 3

1968-1969 Irrigation Year

Submitted by Co-operating Agencies
Edited by
Grant L. Nielsen
Project Coordinator

EDMONTON, ALBERTA
July, 1970

S
1A
c. 2.

Digitized by the Internet Archive
in 2020 with funding from
Legislative Assembly of Alberta - Alberta Legislature Library

DEPARTMENT OF THE ENVIRONMENT
LIBRARY

ALBERTA DEPARTMENT OF AGRICULTURE
Water Resources Division
Soils, Geology and Groundwater Branch

Third Annual Report

Irrigation Study Basin, 1969

I.H.D. Project

IWB - EB - 14

ALTA - 71

Co-operating Agencies

Alberta Dept. of Agriculture;
Water Resources Division
Canada Dept. of Agriculture;
Lethbridge Research Station
Canada Dept. of Energy, Mines and Resources;
Inland Waters Branch
Canada Dept. of Transport;
Meteorological Branch
Research Council of Alberta;
Groundwater Division
St. Mary River Irrigation District
P.F.R.A.

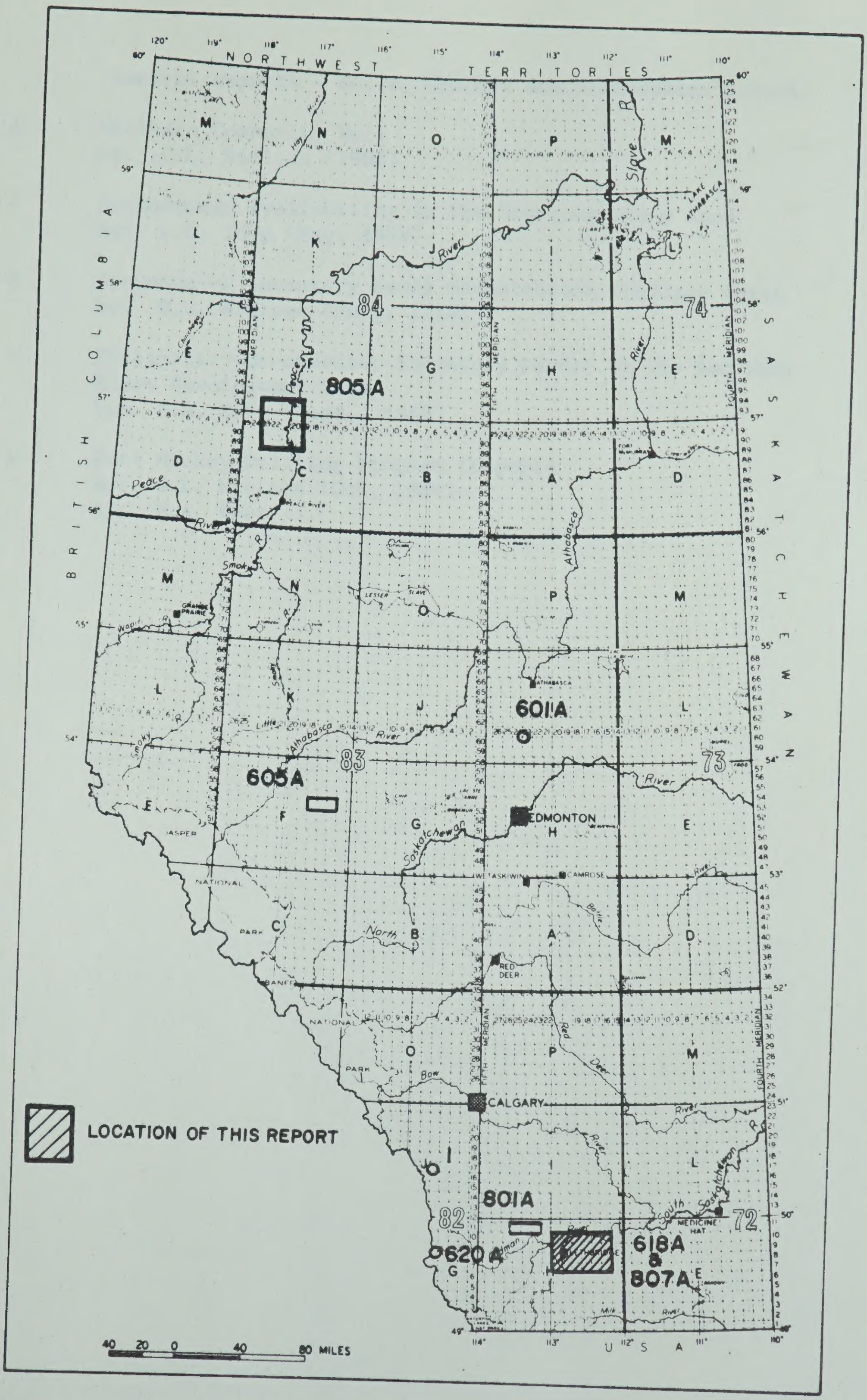
Edited and arranged by:

Grant L. Nielsen, P. Geol.
Project Co-ordinator

Edmonton, Alberta
July, 1970

Detailed reports - Soils, Geology and Groundwater Branch

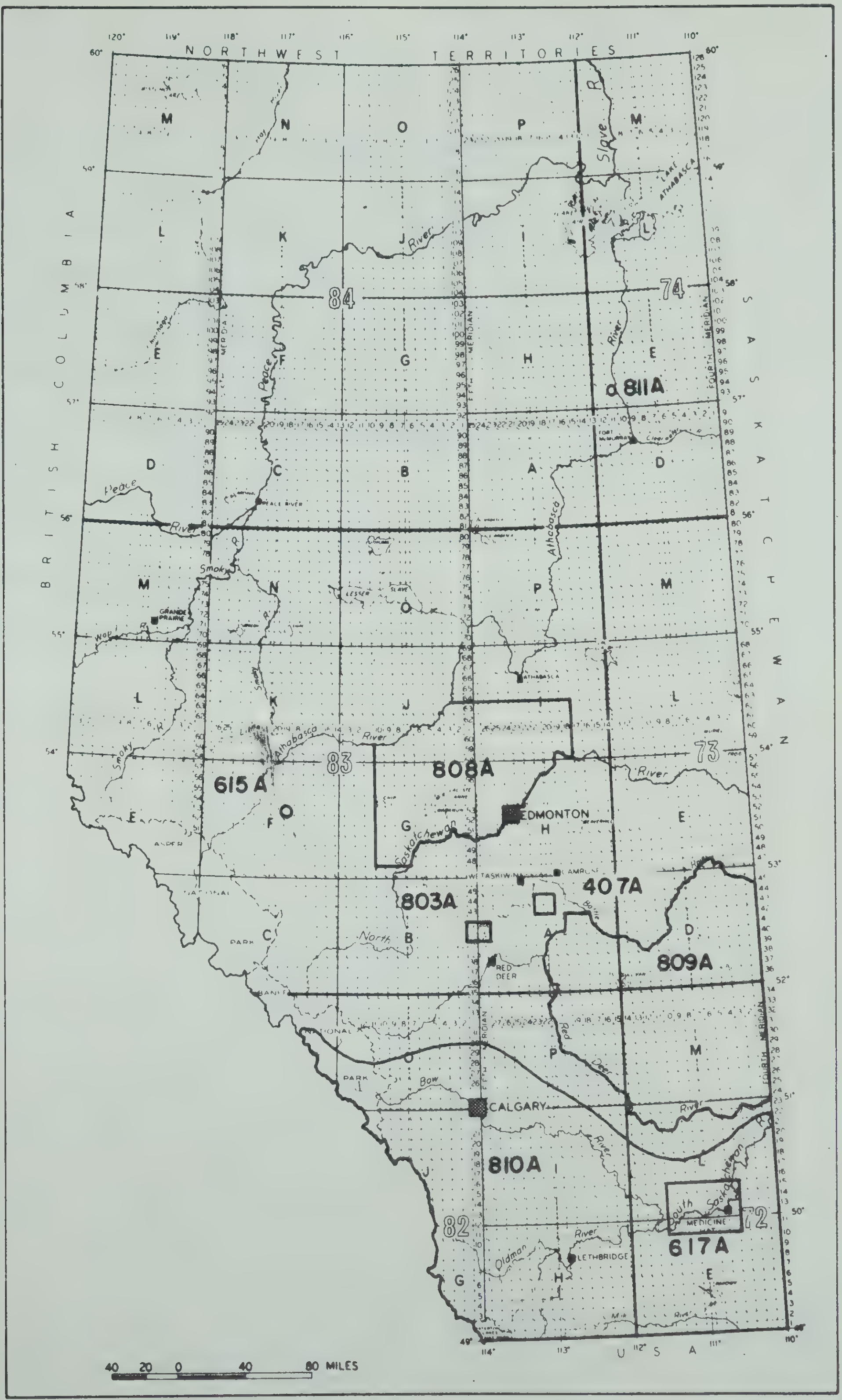
1	A core of the Mount Head and Livingstone Formation Highwood River area, Alta. by: G.L. Nielsen, (Sept., 1965) In Bulletin of Canadian Petroleum Geology Vol. 13, No. 3 (Sept., 1965) pp. 441-447
620 A	Groundwater Geology of West Coleman, Alberta. by: G.L. Nielsen, (Oct., 1965)
601 A	Preliminary Report, Clyde Groundwater Project, Water Resources Division by: G.L. Nielsen, (1965)
618 A	Irrigation Study Basin Annual Rept. No. 1, Calendar Year 1967 by: G.L. Nielsen, (March, 1968)
807 A	Irrigation Study Basin Annual Rept. No. 2, Calendar Year, 1968 by: G.L. Nielsen, (March, 1969)
801 A	Granum East Water Supply Study by: H.A. Kerr, (April, 1968)
605 A	Edson Aquifer Testing Program Edson, Alta. A.R.D.A. Project No. 28056 App. E by: G.L. Nielsen, (March, 1969)
805 A	Preglacial Channel Groundwater Study, Manning, Alta. Groundwater Section
812A	Irrigation Study Basin Annual Rept. No. 3, Irrigation Year, 1968 - 1969



Location of detailed report areas.

General reports - Soils, Geology and Groundwater Branch

615 A	Marlboro Community Well by: G.L. Nielsen (1968)
808 A	Groundwater Availability in the Sturgeon Study Area by: L.C. Topp (May, 1969)
810 A	Groundwater Inventory South Saskatchewan Drainage Basin by: G.L. Nielsen (July, 1969)
809 A	Preliminary Groundwater Inventory Report of the Red Deer River Development Study by: H.A. Kerr (Sept., 1969)
811 A	Fort Mackay Drilling Program (Report) by: G.L. Nielsen (Oct, 1969) by: H.A. Kerr



Location of general report areas.

TABLE OF CONTENTS

Introduction 1

Precipitation.. 2

Surface runoff....................................... 6

Evaporation.. 8

Land Utilization and evapotranspiration............. 10

Irrigation and water flow data..................... 16

Groundwater... 18

Hydrologic budget................................... 20

References.. 21

FIGURES

1. Precipitation (inches) May to September, 1969 4
2. Storm dates, duration, and total precipitation as related to crop growth period.. 5

TABLES

1. Precipitation, November, 1968 - October, 1969............... 3
2. Water flow data - May 1 to October 31...................... 7
3. Evaporation data.. 9
4. Evaporation from open water surfaces....................... 9
5. Distribution of acreage within the study basin.............. 11
6. Non-Irrigated crop acreage................................. 12
7. Irrigated crop acreage..................................... 12
8. Evapotranspiration (inches), May 1 to October 31st, 1969..... 13
9. Irrigated crop acreage and water data....................... 14
10. Non-irrigated crop acreage and water data.................. 15
11. Irrigation data.. 19

INTRODUCTION

The Irrigation Study Basin was organized in 1965 to study all hydrologic aspects of an irrigated area. The project has as its specific goal the establishment of a hydrologic budget for the basin. Most of the instrumentation is oriented to this goal. In addition, specific aspects of irrigation practice and water use are being studied on an intensive basis. This is the first such overall research project to be conducted on an irrigated area in the Canadian prairies.

Two previous reports of progress have been prepared, so this is the third of the series, in which the nature of irrigation hydrology of a research basin is being analysed in detail.

It was decided in 1969 to make these annual reports coincide with the irrigation year, not the calendar year, in order to better evaluate parameters on an annual basis. This report, then, is of an interim nature, covering November 1, 1968 to October 31, 1969.

Several square miles of the basin area have been eliminated north of Cranford as this area contributes only minor runoff within the originally defined area. More problems of measurements arise from leaving it in than from removing it. This reduction, plus a small correction of the calculated area, results in a new basin area of 248,500 acres or about 389 square miles.

PRECIPITATION

Precipitation for the basin is shown in Table 1. From April to October, 1969, records from all 27 standard rain gauges were used. From November, 1968 to March, 1969, the records from the two stations having Nipher snow gauges were used. Station 26 is the Department of Transport station at Lethbridge Airport. As was shown in the 1968 report (p. 3,4), there is little difference between results from averaging all stations and values calculated from planimetering the plotted annual values. Therefore the former has been done, as it is considerably simpler.

As is usual for this area, summer rainfall (May - September, 1969) was greatest in the west and least in the east, decreasing from 9.5 to 6.5 inches eastward (Figure 1).

Total annual precipitation averaged 12.63 inches for the entire basin, or 261,500 acre-feet of water. The average precipitation during April was well below normal, May was half the normal, June was well above normal, July was slightly below normal, and August and September were well below normal.

Figure 2 shows the dates of storm durations and precipitation through the crop growth period of various crops. Were it not for irrigation, sugar beets and forage crops would have been hit particularly hard by a lack of moisture.

TABLE 1

PRECIPITATION, November, 1968 - October, 1969

Site	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
1	M	1.27	1.55	0.75	0.33	0.17	0.81	4.28	1.28	0.05	0.81	0.79	
2						0.17	0.95	4.44	0.93	0.21	0.52	0.68	
3						M	1.14	5.13	1.77	0.16	0.42	0.71	
4						0.30	1.15	4.52	1.20	0.04	0.65	0.54	
5						0.64	1.48	5.32	1.08	0.00	0.55	0.63	
6						0.32	1.07	5.11	1.76	0.04	0.46	0.72	
7						0.18	0.94	4.31	1.36	0.27	0.76	0.68	
8						0.24	0.89	4.18	1.33	0.25	0.33	0.75	
9						M	0.72	4.06	1.08	0.18	0.73	0.75	
10						0.17	0.83	3.59	0.85	0.28	0.62	0.55	
11						0.16	0.71	4.05	1.03	M	M	M	
12						0.20	1.13	4.46	M	0.23	0.44	0.71	
13						0.16	1.00	4.25	1.05	0.25	0.63	0.62	
14						0.22	0.91	4.74	0.89	0.05	0.50	0.71	
15						0.19	1.09	M	M	0.00	0.45	M	
16						0.25	0.75	5.11	1.03	0.12	0.40	0.62	
17						0.30	0.78	5.76	1.36	0.00	0.44	0.77	
18						0.34	1.19	5.97	1.83	0.05	0.46	0.64	
19						0.44	1.25	5.78	1.24	0.00	0.43	0.70	
20						0.42	1.21	4.63	1.62	0.22	0.55	0.73	
21						0.28	1.23	4.65	1.10	0.16	0.59	0.75	
22						0.26	1.08	4.38	1.33	0.32	0.34	0.80	
23						0.27	1.09	3.73	1.18	M	0.38	0.64	
24						0.48	1.39	5.19	1.25	0.00	0.48	0.42	
25						0.24	0.77	4.40	1.45	0.00	0.48	0.63	
26	0.07	1.59	1.44	0.58	0.62	0.35	1.58	5.20	1.54	0.10	0.55	0.52	
27						0.26	0.75	3.78	0.94	0.17	0.62	M	
Average	0.07	1.43	1.49	0.66	0.47	0.28	1.03	4.65	1.26	0.13	0.52	0.64	12.63
Normal	1.05	0.78	0.88	1.05	1.06	1.36	2.09	3.20	1.69	1.64	1.36	1.07	17.23

M - Missing Data

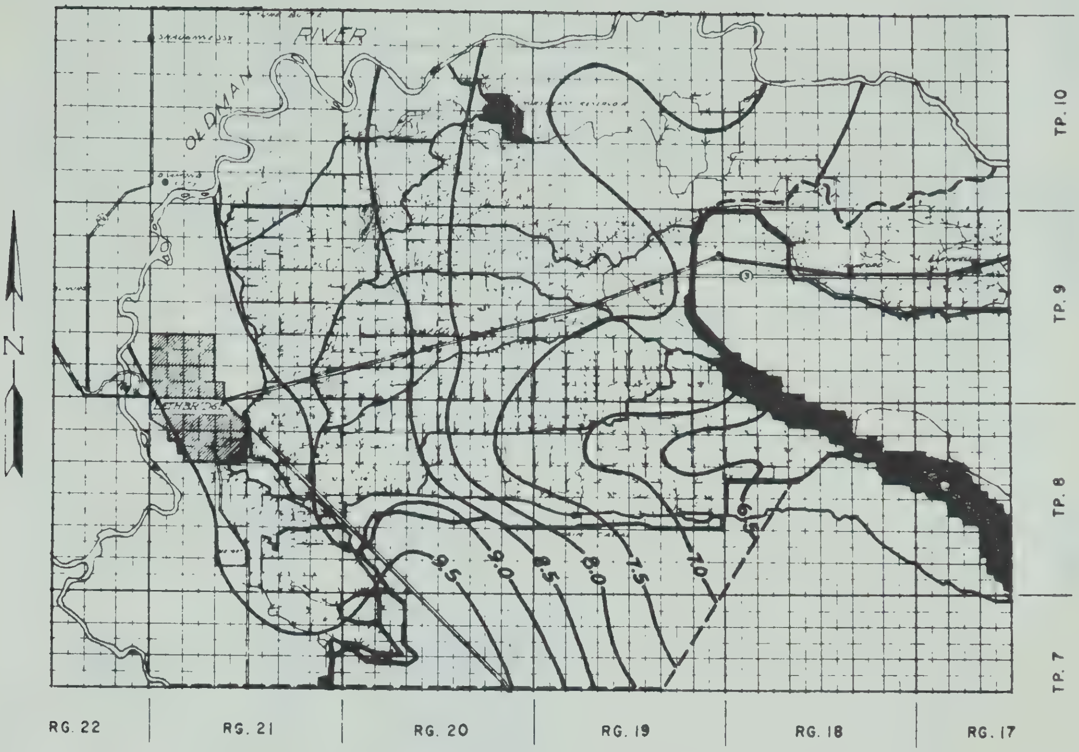
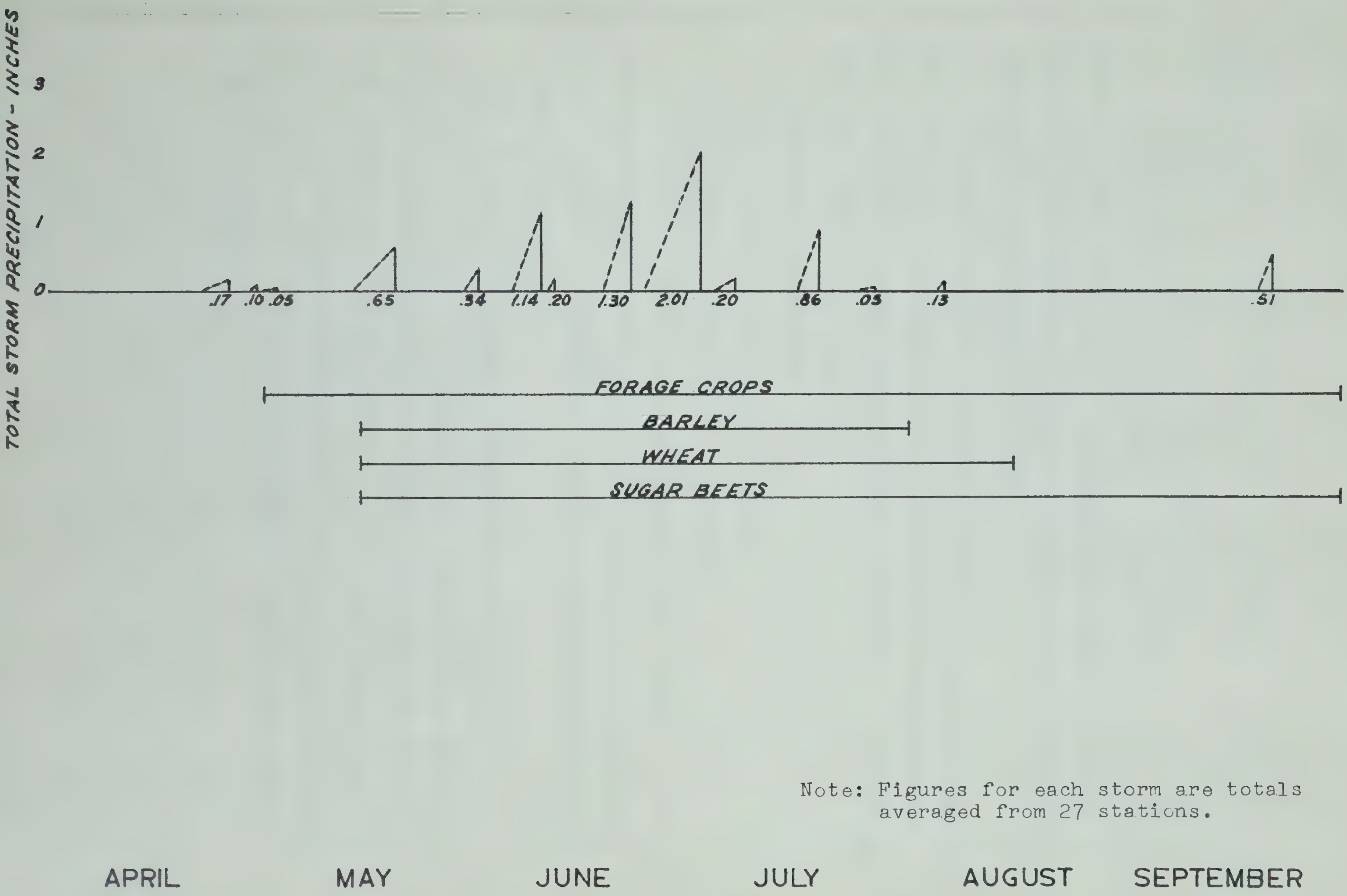


FIG. 1 Precipitation (inches) May - Sept., 1969



Note: Figures for each storm are totals averaged from 27 stations.

FIG. 2 - Storm Dates, Duration, and Total Precipitation as Related to Crop Growth Period

SURFACE RUNOFF

Natural surface runoff to rivers, as is typical in the southern prairies, occurs only from a small portion of the basin, and is very low. Surface runoff this year has not been divided into that resulting from precipitation, as distinct from that resulting from irrigation.

During 1969. Water Survey of Canada operated five stream-gauging stations. Three others were discontinued, because three years of records showed that they were serving no useful purpose. Virtually no discharge occurred through these three. Those discontinued were:

Nolan Coulee near Coaldale

Chin Reservoir Outflow to Bountiful Coulee

Taber Irrigation District canal near Cranford

Four of the five operating stations measure return flow from the irrigation system, while the fifth measures the diversion to the Readymade mini-basin, as well as the releases from St. Mary Main Canal previous to its spillage into Chin Reservoir.

The St. Mary River Irrigation District distributes water within the district and meters inflow to the basin. Table 2 lists the water flow at various points entering and leaving the basin. Total natural and irrigation runoff from the basin is 25,164 acre-feet, or 64.5 acre-feet/square mile. Natural runoff was higher than usual because of the absence of chinooks during the winter of 1968-69. Consequently more snow than usual remained in the spring to melt and run off.

TABLE 2 WATER FLOW DATA - MAY 1 to OCTOBER 31

	(Acre-feet)
Main Canal flow past the Lethbridge-Coaldale diversion[a]	191,601
Main Canal out (to Chin Reservoir)[a]	183,633
Delivered to Lethbridge-Coaldale laterals[a]	96,086
Delivered to Readymade extension (lateral 1)[c]	3,310
Irrigation Turnout from Readymade extension lateral[b]	1,914
Readymade effluent to Chin Reservoir[e]	1,250
Effluent from Lethbridge-Coaldale system	
Chin Butte Spillway (Return to Main Canal)[a]	7,923
Malloy Drain[a]	17,870
Cameron Spillway (et. al.)[c]	8,990
To Bountiful Coulee[c,d]	4,150
Lateral 10[c]	334
To Henderson Lake[a]	300
Irrigation Turnout to secondary laterals	f
Effluent from secondary laterals	
To Farm Turnout[b]	49,868
To Six Mile Coulee	f
To Nolan Coulee	Nil
To Malloy Drain[f]	f
Six Mile Coulee[c]	1,260

Sources:

(a) Read by S.M.R.I.D.
(b) Estimated by S.M.R.I.D. Ditchriders
(c) Read by Inland Waters Branch
(d) Includes approximately 50 A.F. spill from Chin Coulee and an unestimated quantity from the T.I.D.
(e) Estimate.
(f) Not metered or estimated.

EVAPORATION

Class A pan evaporation, corrected to actual lake evaporation, is shown in Table 3 for the five month growing season. The correction is that used by Kohler, Nordensen and Fox (1955). Evaporation from water surfaces within the basin is shown in Table 4, although most of this is calculated for the period of May 5 - October 21. Evaporation during the rest of the year is low compared to this five and one-half month period, when irrigation water is present and temperatures are high. The total evaporation loss of 7,145 acre-feet from 2,655 acres of open water surface is about 2,69 feet, or 32.3 inches. This is in close agreement with the lake evaporation of 31.26 inches computed in Table 3. Total evaporation, including that from non arable areas is 11,695 acre-feet.

TABLE 3 EVAPORATION DATA (inches)

	Class A Pan. Ep				Lake Evaporation, E_L[a]			
Site / Month	1	4	26	Average	1	4	26	Average
May	9.62	9.10	8.53	9.08	6.73	6.54	6.23	6.50
June	6.40	6.15	6.35	6.30	5.05	4.71	4.64	4.80
July	8.33	8.12	9.89	8.78	6.53	6.63	7.26	6.81
Aug.	11.70	10.96	12.89	11.85	8.37	7.90	8.67	8.31
Sept.	6.80	6.52	7.19	6.84	4.77	4.65	5.10	4.84
Total	42.85	40.85	44.85	42.85	31.45	30.43	31.90	31.26

TABLE 4 EVAPORATION FROM OPEN WATER SURFACES

	Open Water Surface (acres)	Evaporation Loss (acre-feet)
1. Main canal and laterals[b]	600	1,632
2. Secondary laterals[b]	110	299
3. Farm Ditches[b]	180	489
4. Lakes[b]	1,060	2,883
5. Dugouts[b]	75	204
6. Ponds, Sloughs, etc.	610	1,586
7. Borrowpits	20	52
	2,655	7,145

(a) Corrected from Class A pan Evaporation by the formula

$$E_L = 0.70\ [\ Ep + 0.0051\ P\alpha p(0.37 + 0.0041\ Up)\ (To - Ta)^{0.88}\ ]$$

Kohler, et al., (1955). U.S. Dept. of Commerce Research Paper No. 38

(b) Evaporation period reduced to that portion of the season for which water is present (May 5th - October 21st).

LAND UTILIZATION AND EVAPOTRANSPIRATION

The various uses to which land is put within the basin are shown in Table 5. Of the 239,440 acres of agricultural land, 36 per cent is irrigated. Tables 6 and 7 show crops grown on non-irrigated and irrigated land. Crop acreage information was collected mainly from Canadian Sugar Factory, Cornwall Canning Company, Alberta Canning Company, and by visual inspection.

Evapotranspiration of water from these various crops is shown in Table 8, in inches. Water use by irrigated crops and non-irrigated crops is shown in Tables 9 and 10 respectively. Total evapotranspiration calculated for both irrigated and non-irrigated areas is 215,400 acre-feet for the six month growing season. Average evapotranspiration for non-irrigated areas is 0.68 feet, or 8.1 inches. Average evapotranspiration for irrigated areas is 1.29 feet, or 15.5 inches. It is considered to be the sum of water received during the growing season plus the difference between spring and fall moisture, based on soil moisture studies at the Lethbridge Research Station. During the other six months, 4.40 inches of precipitation fell, of which half, or 2.20 inches are assumed to have evaporated. The balance contributed to soil moisture, runoff, etc.

TABLE 5 DISTRIBUTION OF ACREAGE WITHIN THE STUDY BASIN

Cropped Acreage		232,300
Urban		4,870
Uncultivated		
buildings[a]	38	
corrals, misc.[a]	26	
access roads[a]	27	
access crossings	43	
head ditch banks[a]	178	
retired laterals	28	
Total -		340
Water Surface		
irrigation ditches[a]	178	
lakes	1,058	
canals	600	
secondary laterals	110	
dugouts[a]	74	
ponds, sloughs[a]	610	
borrowpits (under water)	20	
Total -		2,650
Non-Arable		
paved road (non-urban)	245	
gravel road	905	
railroad bed	50	
Total -		1,200
Grassed Areas		
borrowpits (not under water)	2,980	
canal banks	1,570	
Total -		4,550
Phreatophytes		
on canal banks	235	
alongside lakes, sloughs, river	2,355	
Total -		2,590
Total Acreage		248,500

(a) estimated

TABLE 6 NON-IRRIGATED CROP ACREAGE[a]

CROP	
wheat	48,761
oats	810
barley	10,436
rye	910
flax	1,189
rapeseed	500
forage	1,189
pasture	29,192
summerfallow	56,443
phreatophytes	1,361
grassed area	
borrowpits	1,790
Total -	152,581

TABLE 7 IRRIGATED CROP ACREAGE[a]

CROP	
wheat	7,727
oats	8,049
barley	25,285
flax	793
sugar beets	9,879
potatoes	96
corn	50
peas	2,540
beans	35
carrots	93
onions	6
forage	24,787
pasture	1,530
summerfallow	2,000
phreatophytes	
canal banks	235
adjacent to canal banks	605
other areas	389
grassed areas	
borrowpits	1,190
canal banks	1,570
Total -	86,859

(a) Data taken from permit records, factory and cannery records and visual inspection.

TABLE 8 EVAPOTRANSPIRATION (INCHES) May 1st to October 31st, 1969

Crop	Estimated Use of Pre-season Moisture	Precipitation during the Growing Season	Average Effective[a] Irrigation	Evaporation while Fallow	Total Evapotranspiration
Not Irrigated					
Grain	3.0	6.85	0	1.40	11.25
Forage	2.6	7.44	0	0	10.04
Summerfallow	0	7.44	0	5.00[b]	5.00
Irrigated					
Grain	3.0	6.77	1.08[c]	1.60	12.45
Forage	2.6	7.44	4.51	0	12.55
Sugar Beets	1.0	7.39	10.31	0.30	19.00
Peas	0.5	5.85	3.45	2.60	12.40
Misc. Vegetables	0.5	6.75	3.45	2.20	12.90
Summerfallow	0	7.44	3.69	5.00[b]	5.00

(a) Effective irrigation taken to be 50% of water diverted to farm, excepting wheat crops for which the figure used is 70% due to drier conditions at the time of irrigation including stubble.

(b) Estimate.

(c) Does not include fall irrigation.

TABLE 9

IRRIGATED CROP ACREAGE AND WATER DATA (X1000)

Crop	Area (Acres)	Evapotranspiration (ac.-ft.)	Pre-season Moisture (ac.-ft.)	Precipitation (ac.-ft.)		Effective[a] Irrigation (ac.-ft.)	Runoff (ac.-ft.)
		[f]		[f]	[g]		
Grain	41.85	43.44	13.25	26.47	44.05	6.36[c]	
Vegetable	12.70	19.02	4.02	8.03	13.37	9.30	
Forage	26.32	31.91	8.33	16.65	27.70	9.90	
Summerfallow	2.00	0.83	0.63	1.27	2.10	0.62	
Phreatophyte	1.23	2.58	0.39	0.78	1.29	-	
Grassed Area							
borrowpit	1.19	2.14	0.38	0.75	1.25	5.50[d]	0.4[h]
canal bank	1.56	3.25	0.49	0.99	1.64	1.77[e]	

(a) Effective irrigation taken to be 50% of water diverted to farm, excepting wheat crops for which the figure used is 70% due to drier conditions at the time of irrigation including stubble. Of the total diversion to farm turnouts, an estimated 3,000 A.F. was lost due to evaporation from sprinklers, 5,500 A.F. to runoff and 14,925 A.F. to percolation and seepage from dugouts, ditches, and due to over-irrigation in parts of irrigated fields.

(b) Estimate.

(c) Includes 2,600 A.F. for fall irrigation.

(d) Runoff from irrigated fields.

(e) Sub-irrigation derived from canal seepage.

(f) May 1st - September 30th, 1969.

(g) November 1st, 1968 - October 31st, 1969.

(h) Includes 0.4 A.F. precipitation runoff from roads.

TABLE 10 NON-IRRIGATED CROP ACREAGE AND WATER DATA (X1000)

Crop	Area (Acres)	Actual Evapotranspiration (ac.-ft.)	Pre-season Moisture[c] (ac.-ft.)	Precipitation (ac.-ft.)		Precipitation Runoff (ac.-ft.)
				a	b	b
Grain	62.61	58.70	19.83	39.60	65.90	-
Forage	30.55	25.56	9.67	19.32	32.15	-
Summerfallow	56.45	23.52	17.88	35.70	59.41	-
Phreatophytes	1.36	2.95	0.43	0.86	1.43	-
Grassed Area borrowpit	1.79	1.50	0.57	1.13	1.88	0.6[d]

(a) May 1st to September 30th, 1969.

(b) November 1st, 1968 to October 31st, 1969.

(c) Estimate.

(d) Precipitation runoff from roads.

IRRIGATION AND WATER FLOW DATA

The gross irrigation diversion to farm headgates provided by the S.M.R.I.D. was estimated from ditchrider records, as 49,868 acre-feet (See Table 11). The total water metered into the system, however was 96,086 acre-feet, the balance being return flow, seepage loss, evpotranspiration, etc.

It should be emphasized that the quantity of water delivered, as shown in Table 2, is actually the amount requested by farmers. Ditchriders divert what they estimate to be a larger amount into secondary laterals to ensure that the requested flow reaches the headgates. Spot flow measurements conducted by the Agrohyrology Branch, Alberta Department of Agriculture, show that these estimates are often highly erroneous.

Moreover, these figures do not show that a substantial part of this is not used at night and becomes wastewater. Some of it flows back into the canal system through Malloy Drain and the coulees draining into Chin Lake. Part also flows into the Oldman River through Six Mile Coulee and Bountiful Coulee.

Furthermore, due to the poor conditions of some of the laterals, farmers often request more than they receive. This is amplified by the fact that farmers whose turnouts are closer to the canal are generally able to get more water than they have asked for by opening their gates wider and taking some of the water designated for parcels further downstream. This phenomena will be reflected in the distribution of the water between the various crops.

It was not possible to make proper corrections in the ditchrider data. This data was used without correction in the remaining part of the report.

Soil moisture values in Tables 6 and 7 are an average of several years data of soil moisture before planting and after harvest for several crops. As such, they are not used in the hydrologic budget of the basin, and the actual moisture is included in evapotranspiration data.

Deep percolation, seepage from dugouts and ditches, and over-irrigation in certain areas account for 14,925 acre-feet of irrigation water. This is in the same order of magnitude as the volume of groundwater discharge, as calculated independently by another contributor.

GROUNDWATER

Most active groundwater recharge occurs within the irrigated parts of the basin, where water is available for recharge during the entire year, except for the period of ground-frost (about 4.75 months of the 1968-69 irrigation year). The volume of groundwater discharge was calculated to be about 11,200 acre-feet for the year 1968-69, equivalent to 14.5 igpm per square mile. About 114 igpm, or 2 per cent of this volume flowed into the basin through the Stirling pre-glacial channel from the south.

For more complete treatment of geology and groundwater behavior and chemistry, see "Hydrogeology of the Irrigation Study Basin, Oldman River Drainage, Alberta, Canada," soon to be published in B.Y.U. Geology Studies, by the author. These figures are somewhat different from those of the report of the 1968 calendar year, and are based on more complete data. Groundwater storage at the end of the irrigation year was 1,242 acre-feet less than a year earlier, as averaged from 15 deep piezometer records.

TABLE 11 IRRIGATION DATA[a]

CROP	WATER DELIVERED (A.F.)
Sugar Beets	16,971
Hay	9,925
Pasture	8,182
Wheat	3,787
Stubble	3,721
Barley	1,812
Alfalfa	1.520
Vegetables	1,472
Fallow	879
Pond	843
Oats	298
Flax	24
Miscellaneous[b]	434
Total	49,868

(a) Data provided by S.M.R.I.D., compiled from ditchrider books, 1969.

(b) Miscellaneous is made up of lawn, yards, and those acreages for which the crops are not known.
For the rest of the report it has been assumed that the distribution of this acreage is as follows:

Grain	80
Forage	173
Vegetables	156
Lawn, other	25

HYDROLOGIC BUDGET

The hydrologic budget for the 1968-69 season covers the full 12 month irrigation year. Although the change in surface water storage was not evaluated, it is likely of small compared to the other parameters. The hydrologic equation is:

$P + I = E_t + Q_s + Q_g + \Delta S_m + \Delta S_g + \Delta S_s$, in which

P= precipitation

I= irrigation

E_t= evapotranspiration

Q_s= surface outflow

Q_g= groundwater outflow

ΔS_m= change of soil moisture storage

ΔS_g= change of groundwater storage

ΔS_s= change of surface water storage

Expressed in acre-feet, the budget is as follows:

$$\underbrace{261{,}500 + 49{,}868}_{311{,}368} = \underbrace{272{,}645 + 25{,}164 + 11{,}200 + ? - 1{,}242 + ?}_{308{,}867}$$

In inches of water over the basin, this is equivalent to:

$$12.67 + 0.24 = 10.99 + 1.01 + 0.54 + ? - .05 + ?$$

Each of these parameters has been evaluated independently, so a complete balance between the two sides of the equation was not reached, nor scarcely could be expected. Nevertheless, they do agree quite closely to each other. The greatest difficulties of calculation are probably in evapotranspiration and groundwater flow.

REFERENCES

Kelly, Jon, (1970): Fourth annual report, November 1, 1968 to October 31, 1969, Irrigation Study Basin; dated March 20, 1970, Lethbridge.

Kohler, M.A., Nordensen, T.J., and Fox, W.E., (1965): Evaporation from pans and lakes; U.S. Weather Bureau, Research paper 38.

Nielsen, G.L., (1969): Irrigation Study Basin annual report no. 2, calendar year 1968; Alta. Dept. of Agric. rept.

__________ , (1970): Hydrogeology of the Irrigation Study Basin, Oldman River drainage, Alberta, Canada; Unpublished dissertation, Brigham Young University, Dept. Geol.

ALBERTA DEPARTMENT OF AGRICULTURE

WATER RESOURCES DIVISION

R.E. Bailey, Director

The Water Resources Division, Alberta Department of Agriculture, is the agency entrusted with administering all surface water and ground water legislation in the province. In addition, the division is often able to aid in solving water problems that the public may have. In order to do so intelligently, research projects of various types are conducted. These take the form of damsite and canal investigations, river studies, watershed research, and groundwater inventory work.

Where the above studies are of general interest, the results are published in reports which are freely available to interested persons or groups.

Each inquiry received is considered as an opportunity to serve the public. For further information, write to: The Director, Water Resources Division, Department of Agriculture, Agriculture Building, Edmonton 6, Alberta.